

## Reduced Congestion and Improved Mobility

IVHS can help reduce street and highway congestion in a number of ways. Information provided to travelers will permit many to avoid congestion by allowing them to go around the congestion, choose alternative modes of transit, or delay their trips.

Rapid detection and clearing of accidents and incidents will reduce congestion and the secondary collisions that frequently result and cause additional delays. Enhanced public transportation systems can divert highway traffic. Real-time, dynamic traffic control systems will adapt to traffic conditions automatically.

Electronic Toll and Traffic Management (ETTM) can reduce congestion around toll plazas by collecting tolls automatically and can provide the basis for congestion pricing, a demand management tool for which ISTEA has authorized an R&D program.

Congestion is not simply an urban issue. In rural areas, traffic is disrupted by accidents, construction and maintenance operations and associated detours, congestion on tourist routes, and other causes. IVHS can help alleviate all these problems.

There will be new flexibility in organizing car- and van-pools. This will increase the number of vehicles with multiple riders, thus reducing the total number of vehicles in the traffic stream. Guiding drivers directly to available parking spaces is yet another way IVHS will reduce congestion.

Improved mobility as well as improved convenience and comfort for all surface transportation is a goal IVHS can help fulfill. Better information — for example, real-time transit schedules and intermodal connection information — can make public transportation more marketable to potential riders. Better information on volunteer services and transit schedules will enhance the mobility of older Americans and disabled travelers in urban and rural areas.

According to estimates, traffic congestion can be reduced as much as 20 percent by 2011 in cities that adopt IVHS technologies.

## Enhanced Economic Productivity

The importance of efficient transportation to the nation's economic health cannot be overstated; nearly all economic activity uses transportation directly or indirectly. Improving the efficiency of our transportation system will boost economic productivity.

Operators of many commercial and public-sector fleets will realize a variety of economic benefits from IVHS, including safety improvements, minimized delays due to traffic congestion, efficient routing of vehicles, and quicker movement of freight by such innovations as

## Energy Efficiency and Environmental Quality

electronic toll collection and in-motion electronic identification of vehicles crossing state lines.

Minimizing congestion and diverting passengers from single-occupancy vehicles will increase the energy efficiency of the transportation system. Emissions will be reduced by smoother, more evenly distributed traffic flow, as well as by increases in the use of public transit and car- and van-pooling. There is some concern that any congestion relief may merely encourage more travel, thus negating most if not all gains in reduced energy consumption and pollution. This question must be researched. But it should be noted that IVHS provides the means to implement demand management systems based on road-pricing, if public policy determines this to be a desirable way to limit or shift demand.

## IVHS Participants: Roles and Responsibilities

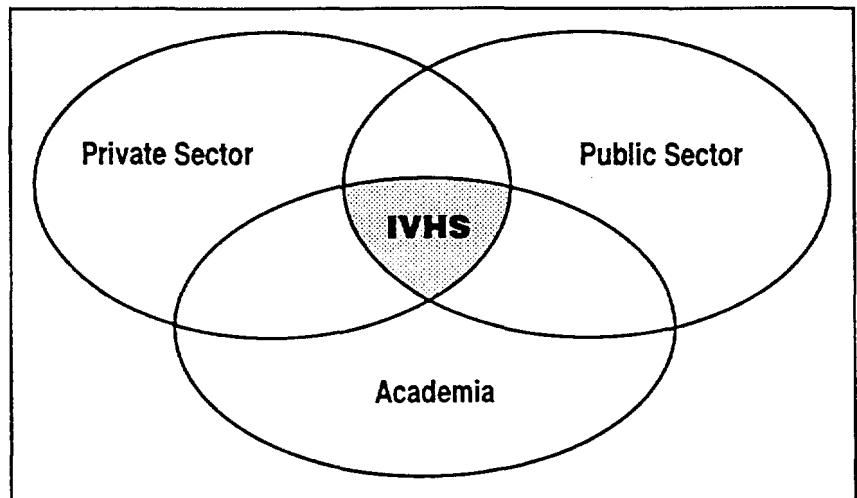
IVHS embodies a wide array of technologies, but the challenges are not solely technical. Organizational, institutional, and legal issues must be resolved before significant implementation can take place. In fact, implementing IVHS will require unprecedented cooperation among all levels of government, the private sector, and academia. IVHS can serve as a national model for the deployment of technology-based systems where public and private sector coordination is a central concern. Every sector is crucial — key needs include the following:

- Development of new public/private partnerships
- New forms of cooperation among local, state, and federal agencies
- Agreement on an overall system architecture
- Stable R&D funding and management
- Adoption of appropriate standards and protocols
- Education of a new generation of transportation professionals

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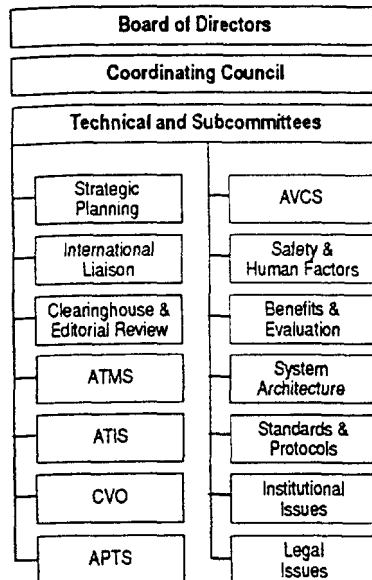
*"Implementing IVHS will require unprecedented cooperation among all levels of government, the private sector, and academia."*

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## IVHS AMERICA

### IVHS AMERICA Organization



A leading role in the design of a national program of IVHS research, development, and deployment will be played by the Intelligent Vehicle Highway Society of America (IVHS AMERICA). Its mission is to stimulate interest and activity in IVHS and to coordinate and foster public/private/academic partnerships that will make the U.S. transportation system significantly safer and more effective. IVHS AMERICA is a forum where the private and public members of the IVHS community come together to reach consensus and take action to accelerate implementation of the technology. A major function of the society is to coordinate development of this Strategic Plan, and, over time, to review progress of IVHS and make necessary modifications to the plan. As a utilized Federal Advisory Committee to the Department of Transportation, it will help guide the federal government's IVHS activities and will advise DOT on establishing program priorities. IVHS AMERICA will also inform the public about the progress of IVHS and its social implications.

IVHS AMERICA will work with established standards-setting bodies to ensure the adoption of workable IVHS standards. For the most part, the organization itself will not create standards. A similar philosophy will guide the approach to research. Research needs will be identified and appropriate agencies and organizations, public and private, will be urged to carry out the work.

## Private Sector

### Partnership Responsibilities

#### IVHS AMERICA

- Maintain Strategic Plan and clearinghouse
- Provide forum for solving problems
- Evaluate and advise

#### Federal Government

- Fund and manage research and testing
- Remove institutional barriers

#### State and Local Government

- Deploy IVHS
- Operate and maintain IVHS

#### Professional Societies

- Develop standards
- Disseminate information

#### Private Sector

- Develop products
- Market products
- Act as research partner

#### Federal Labs

- Transfer technology
- Provide development expertise

#### Academia

- Educate IVHS professionals
- Act as research partner

The private sector's role in IVHS is fundamental. Industry will make by far the largest investment in IVHS, but only in expectation of profits. The marketing of IVHS products and services is best understood by the private sector, which will develop the technology and market the wide array of products and services that will make IVHS a reality.

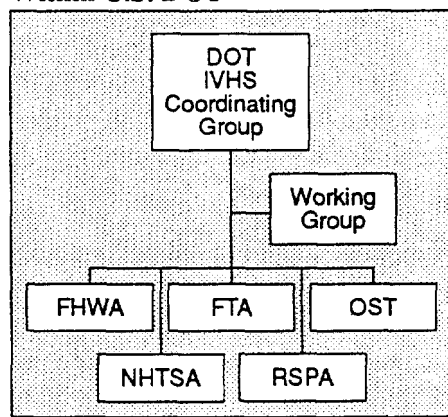
IVHS can be a significant business opportunity for automakers and for companies in the electronics, computer, communications, and information industries. The market is not limited to vehicles — for example, hand-held devices will provide a variety of traveler information, including bus schedules, directories of business listings, and tourist attractions. Similar information services could also be provided on home or office computers.

While significant private investment is required for IVHS to move forward, there may also be a need for government funding to encourage development of consumer products and services that have potential for significant public benefit, but require high-risk R&D programs.

Fulfilling IVHS infrastructure needs will also create a large market. Needs in this area include sensors and actuators, beacons, and hardware and software for electronic toll collection and area-wide traffic management systems.

## The Federal Government

### IVHS Coordination Within U.S. DOT



IVHS calls for development of entirely new public and private roles in transportation. For instance, the private sector could privately finance and operate a variety of infrastructure services, such as collection of traffic data, if it received a franchise from the appropriate public agencies.

The federal government will provide a national perspective on IVHS. Federal spending, as exemplified by the ISTEA, will be required to catalyze private and local spending. The U.S. Department of Transportation (DOT) has the key responsibility for encouraging and coordinating the development of the technology in conjunction with state and local governments, private industry, and academia. DOT will commission research, fund demonstrations and operational tests, assure uniformity of evaluations, encourage implementation, and ensure nationwide compatibility of systems when required.

The Federal Highway Administration (FHWA) has been designated as the lead agency for DOT's program. The Office of the Secretary, as well as other DOT administrations, will also play key roles consistent with their primary responsibilities. Those other key DOT administrations are the National Highway Traffic Safety Administration (NHTSA), the Federal Transit Administration (FTA), and the Research and Special Programs Administration (RSPA).

Other federal agencies will also be involved in aspects of IVHS. These include the Federal Communications Commission, the Department of Energy, the Environmental Protection Agency, the Department of Justice, and the Interstate Commerce Commission.

## State and Local Government

State and local governments are responsible for building, operating, and maintaining surface transportation systems, and for managing traffic. This makes their participation in IVHS fundamental to its success. If IVHS is ignored or rejected by local government, it will fail.

State governments own the Interstate highways, U.S. highways, and state roads. Local governments own arterial highways and local roads. Many transit systems are owned by either state or local government or multi-jurisdictional agencies. State and local governments will install, maintain, and operate the IVHS infrastructure, or they will possibly contract these functions out to the private sector.

Carrying out such programs will require extensive federal assistance. ISTEA emphasizes the importance of Metropolitan Planning Organizations (MPO's) in coordinating region-wide transportation systems.

State and local governments in neighboring jurisdictions must find new ways to cooperate in order to develop and deploy IVHS. Moreover, when systems that reach across jurisdictional boundaries are installed,

## A Strategic Plan for Implementing IVHS

### Academia

cooperation will be required to operate them — coordinating transportation control operations is just one example of such a requirement. Local governments may also want to use IVHS to promote other transportation-related social, political, or economic objectives.

Universities must develop new academic programs that will educate a new type of transportation professional, one schooled in the disciplines and concepts fundamental to IVHS. These include, for example, communications, computer science, systems engineering, and institutional studies. Academia must develop new concepts and knowledge germane to IVHS and must integrate new academic disciplines with transportation. Academia will also help implement this Strategic Plan, assessing the current state of likely technological improvements and performing basic and applied R&D and operational tests.

To guide the implementation of IVHS, Congress requested DOT to prepare a strategic plan. DOT, in turn, asked IVHS AMERICA to prepare its own strategic plan to serve as a foundation for the Congressional report. In writing its plan, IVHS AMERICA received inputs from the broad IVHS community, including federal, state, and local government agencies; industry; academia; trade associations; and consumer and public-interest groups.

The purpose of the Strategic Plan is to guide development and implementation of IVHS technology in keeping with the goals of safety, enhanced mobility, and improved productivity of our transportation system. Foremost among the plan's aims are to:

- Establish the goals and objectives of a national IVHS program and predict its costs and benefits
- Identify key challenges to IVHS deployment and seek ways in which they can be resolved
- Suggest appropriate roles for the public, private, and academic participants and help build cooperation among them
- Outline a course of action to develop, test, and deploy IVHS technology
- Estimate the magnitude and sources of funding required

### Technical Implementation

The Strategic Plan is a road map for IVHS implementation over the next 20 years. But IVHS consists of technologies that continue to advance rapidly. This, therefore, will be a "living plan" that will evolve with changes in technology and experience gained through operational tests and deployment of IVHS.

A series of key assumptions and principles underlie the program for development and deployment. The plan is the IVHS community's consensus — working through IVHS AMERICA — of what must be done. Among the most important of these assumptions and principles are the following:

- Government spending on infrastructure — particularly on advanced traffic management systems — is essential.
- The marketplace will be a major force in the development of IVHS. Consumer acceptance of the various products is also equally essential to success. Other driving forces include the need to provide such public benefits as safety improvements and congestion relief.
- Private sector (and consumer) spending will pay for the bulk of IVHS development, products, systems, and services, especially for in-vehicle products. In some cases, public funding will be needed in early development phases to pave the way for private investment.
- Existing standards should be utilized where appropriate and new standards developed where needed to ensure that different systems work together throughout the U.S. and North America. Systems, products, and services will be developed and deployed within our framework of federalism and the market economy, with decentralized power and decision making.
- Deployment of proven technologies will be emphasized initially.
- R&D will be conducted in areas where existing technologies do not meet requirements or where requirements need to be established (human factors, for example).
- Large-scale operational tests conducted as public/private ventures in real-world conditions are critical to the transition between R&D and commercial deployment of the technologies.
- Benefits of IVHS, while potentially enormous, are difficult to quantify without further study; continuing work should be undertaken. As experience is acquired, estimates of benefits can be refined.

### The Five Functional Areas of IVHS

A wide array of technologies makes up IVHS, including electronics, computer hardware and software, control, and communications. Five functional areas have been identified in which these technologies are applied. These are:

- Advanced Traffic Management Systems (ATMS)
- Advanced Traveler Information Systems (ATIS)

- Advanced Vehicle Control Systems (AVCS)
- Commercial Vehicle Operations (CVO)
- Advanced Public Transportation Systems (APTS)

CVO and APTS are largely applications that use the technologies of the first three areas. All five functional areas apply to transportation in rural areas as well as in urban areas.

#### ADVANCED TRAFFIC MANAGEMENT SYSTEMS (ATMS)

ATMS will integrate management of various roadway functions, including freeway ramp metering and arterial signal control. In more sophisticated implementations, ATMS will predict traffic congestion and provide alternative routing instructions to vehicles over wide areas, in order to maximize the efficiency of the highway network and maintain priorities for high-occupancy vehicles (HOV's).

ATMS will collect, utilize, and disseminate real-time data on congestion on arterial streets and expressways, and will alert transit operators of alternative routes. Dynamic traffic control systems will respond to changing traffic conditions across different jurisdictions and types of roads by routing drivers around delays where possible. Rapid detection and response to traffic incidents will be especially effective in reducing congestion on expressways.

ATMS is the basic building block of IVHS. All other functional areas will utilize the information provided by ATMS.

#### ADVANCED TRAVELER INFORMATION SYSTEMS (ATIS)

ATIS provides a variety of information that assists travelers in reaching a desired destination via private vehicle, public transportation, or a combination of the two.

On-board navigation systems are an ATIS building block. In future systems, these will be augmented by information from the ATMS. The information will include locations of incidents, weather and road conditions, optimal routes, recommended speeds, and lane restrictions. While such information will be utilized in vehicles, it could also be used for pre-trip planning at home, in the office, at kiosks, or even by owners of portable or palm-top computers.

#### ADVANCED VEHICLE CONTROL SYSTEMS (AVCS)

AVCS enhances the driver's control of the vehicle to make travel safer and more efficient. Accidents could be avoided, as opposed to just having their consequences mitigated. AVCS includes a broad range of concepts that will become operational on different time scales.

Collision warning systems would alert the driver to an imminent collision. In more advanced systems, the vehicle would automatically brake or steer away from a collision. Those systems are autonomous to the vehicle and are likely to be developed by the automotive industry and its suppliers. They should offer substantial benefits by

improving safety and reducing accident-induced congestion, justifying public sector funding during the initial development stage.

Longer-term AVCS concepts rely more heavily on infrastructure information and control that could produce major increases in roadway throughput — by as much as two or three times, perhaps more. One example is limited-access, automated lanes, in which the movements of all vehicles are automatically controlled while they are in the special lane. Such a system will likely require close communication between the roadway and the vehicles, and between the vehicles themselves. ISTEA calls for development of a completely automated highway and vehicle system that will serve as the prototype for fully automated IVHS systems. The goal is to have the first fully automated roadway or test track in operation by 1997.

#### COMMERCIAL VEHICLE OPERATIONS (CVO)

Operators of fleets of trucks, buses, vans, taxis, and emergency vehicles have already begun adopting IVHS technologies. Their leadership role is expected to continue because fleet operators can clearly see the economic benefits of implementing IVHS.

Thousands of heavy-duty trucks are already equipped with automated location systems and two-way radios that link drivers with their dispatch centers. Automated Vehicle Identification (AVI) systems are already automating toll collection and thus improving traffic flow in New York, Texas, and Oklahoma. The benefits of electronic toll collection are not limited to commercial vehicles. Indeed, passenger car drivers are the principal beneficiaries — the increased number of vehicles that can move through electronic toll lanes reduces congestion. A number of commercial and public fleet operators use Automated Vehicle Location (AVL) systems — on-board navigation, Loran-C, a terrestrial-based location system, or the Global Positioning System (GPS). With these systems, dispatchers can instantly determine the location of any vehicle.

#### ADVANCED PUBLIC TRANSPORTATION SYSTEMS (APTS)

APTS will use constituent technologies of ATMS, ATIS, and AVCS to improve operation of high-occupancy vehicles, including transit buses and car- and van-pools. ATIS will inform the traveler of the alternative schedules and costs available for a trip, while ATMS will provide instantly updated information. Real-time ride matching is another application that gives car- and van-poolers new flexibility in planning trips.

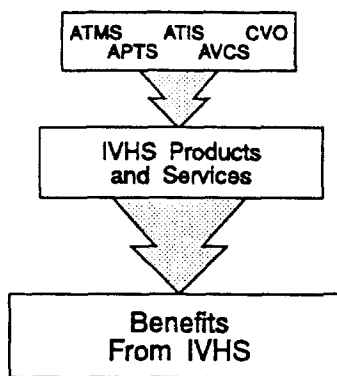
Smart Cards will enable consumers to board transit vehicles, as well as to pay tolls and parking fees, all without cash. In addition, preferential measures (such as selective traffic-signal timing) for HOV's are included in APTS.

## Integration of IVHS Technologies

Successful integration of the separate technologies of IVHS requires that a number of cross-cutting issues and technologies be addressed early in the program. These include system architecture, standards and protocols, system safety and human factors, communications, and operational tests.

IVHS will progress as advanced technology and information are integrated with conventional infrastructure to provide an expanding set of consumer services over ever-increasing geographic areas. As development proceeds, there will be ever-greater interaction among ATMS, ATIS, and AVCS. IVHS can be more than the sum of its parts, but this inherent synergy can be tapped only if it is regarded, from the start, as an integrated set of capabilities.

### IVHS Products and Services



An undertaking as far-reaching as IVHS cannot spring into being overnight. It requires a long-term commitment to a carefully planned and executed program. IVHS is expected to be implemented incrementally — that is, systems will be created separately in various areas of the country. These “islands” will be linked eventually to include the entire nation, much the same way that the Interstate Highway System grew. Phased implementation will hasten delivery of benefits to travelers and will help create public demand for further deployment.

For the consumer, IVHS will provide products and services that will save time and make travel more convenient, safer, or quicker. Much of this Strategic Plan deals with the underpinnings that make these products and services possible — for instance, the hard work involved in integrating a wide range of technologies, or developing standards.

It would be a mistake to forget that the consumer is principally concerned with the personal benefits of a technology, not with issues of integration or standards or possible societal benefits. In the end, consumers will determine the fate of IVHS by voting with their dollars. This suggests the need for very careful attention to human factors in the design of IVHS hardware and software and public education programs to ease the transition to IVHS. Public agencies, which will buy a substantial amount of IVHS hardware, software, and systems, are crucial customers as well.

Figure I-1 shows the IVHS products and services of interest to consumers and the time frames in which they may become available.

KEY IVHS PRODUCTS AND SERVICES (Approximate First Availability)					
Near-Term 1992 – 1996		Mid-Term 1997 – 2001		Long-Term 2002 – 2011	
TRANSPORTATION MANAGEMENT					
■ Local area traffic monitoring and control for 15 metro area corridors and 3 inter-city corridors		■ Area-wide, real-time, adaptive traffic and transit fleet control for corridors in 50 metro areas and 25 inter-city corridors		■ Area-wide, full-featured systems to manage intermodal surface transportation nationwide in large urban areas and major rural corridors	
TRAVELER INFORMATION SYSTEMS					
■ Transportation data available at home, at the workplace, at public kiosks, at stations and transfer points, and through hand-held devices ■ Static route guidance with business/tourist data in new vehicles and as a vehicle after-market product		■ Real-time transportation system condition information for regional and rural travel and multiple modes of transportation ■ Real-time car-pooling connection information ■ Route guidance reflecting dynamic traffic conditions ■ In-vehicle display of road signs		■ Multi-modal demand-responsive information systems ■ Area-wide transportation control integrated with optimal routing	
PRODUCTIVITY ENHANCEMENTS					
■ Productivity management systems for commercial and transit fleets ■ Electronic toll collection ■ Electronic transit fare collection ■ Electronic credential checking		■ Electronic record-keeping for vehicle fleet operations ■ Integrated electronic transit fare, parking, and toll collection ■ Automated HOV lane use verification		■ Transparent borders for commercial vehicles ■ Fully integrated transportation user-fee collection systems	
SAFETY AND DRIVER ASSISTANCE					
■ Roadway and environment safety systems ■ Near-obstacle warning ■ Simple vehicle performance monitoring ■ Adaptive cruise control		■ Automated highway demonstration ■ Semi-automated Mayday capability ■ Passenger security systems ■ Perceptual enhancement systems ■ Vehicle monitoring systems ■ CVO safety inspection systems ■ Collision warning ■ Automated collision avoidance		■ Automated vehicle operation on specially equipped roadways ■ Fully automated Mayday systems with coordinated dispatching ■ Intersection hazard warnings	

Figure I-1.

## Key Institutional and Legal Issues

Technical feasibility is not the sole determinant of whether a technology realizes its promise. Success depends on a broader environment, including institutional, legal, economic, and social issues. These issues are discussed throughout this document, and this section identifies the most important of them.

### Institutional Issues

A principal challenge to IVHS is the need for new relationships among institutions involved in the national program. Agreement on the roles and responsibilities of the participants is the first step in overcoming this challenge.

Many institutions will have to adapt to meet the challenges presented by IVHS. Highway agencies, for instance, will have to build strong expertise in a variety of other disciplines, in addition to the traditional emphasis on civil engineering. Government and industry, frequently adversaries, will have to find means of cooperating. Government procurement practices, which often make joint efforts difficult, may have to be re-examined in light of IVHS.

### Legal Issues

A number of legal issues could greatly affect IVHS R&D and deployment. Resolving these issues will require studies of the problems and forums where the interested parties may seek agreement on the issues confronting them. They then will need to seek legislation to resolve those issues. Key legal issues include tort and product liability, antitrust, privacy, and intellectual property.

### International Cooperation and Competition

Substantial IVHS programs are under way in Western Europe and Japan. The U.S. should not isolate itself from the rest of the world in developing its IVHS program. Doing so might deny U.S. manufacturers the opportunity to penetrate overseas markets or to benefit from overseas technological advances. A much larger, truly international market would be more attractive to manufacturers, and the increased volume would result in economic growth and lower prices at home. Agreement upon international standards and protocols, wherever possible, would help build an international market.

Efforts already under way to create a North American IVHS program are consistent with recent developments toward increased economic cooperation between the U.S., Canada, and Mexico.

### Costs

IVHS will be paid for principally by the users of its products and services: Consumers, commercial users (such as the trucking industry), toll authorities, transit operators, and the like. As in the case of the highways themselves, government infrastructure spending will be the foundation for growth.

The development costs for IVHS will be largely paid for by the private sector in its quest to develop products for what promises to be a very

**IVHS Development  
(R&D and Testing)  
Costs—Next 20 Years**

- Development requires public lead
- 85% private sector
- 15% public sector

**IVHS Deployment  
Costs—Next 20 Years**

- Deployment must be consumer led
- 80% private sector
- 20% public sector

large market. In addition to infrastructure spending, federal government support will be needed to back long range R&D, academic research, and essential activities that cannot be self-sufficient, such as the legal and institutional implications of IVHS. The public sector will also purchase advanced electronic equipment to improve the performance of transit vehicles, with support provided by the Federal Transit Administration.

Market uncertainties, rapidly changing costs for evolving technologies, and other demands for development capital make it difficult to predict the program costs, especially over a 20-year period. Therefore, estimates can only be provisional. As results from operational tests become available, it will be possible to predict consumer interest and total program costs more accurately.

Achieving the aims set out in this Strategic Plan is expected to require a public infrastructure investment on the order of \$40 billion over the next 20 years. End-user spending for products and services over that same period could reach \$170 billion or more, depending on market response. The public expenditure for IVHS may seem large, but it is small relative to expected total public transportation expenditures — less than 3 percent of the \$1.6 trillion expected to be spent on ground transportation in the same period. Cost estimates for the development and deployment of IVHS are given in the following tables; detailed cost analyses are given in Chapter III and Appendix D.

**DEVELOPMENT COST ESTIMATES\***

(\$ Millions)

	Near Term (5 year)	Mid Term (5 year)	Long Term (10 year)	TOTAL
Research and Development	600	900	600	2,100
Operational Testing	1,200	1,200	1,500	3,900
<b>TOTAL</b>	<b>1,800</b>	<b>2,100</b>	<b>2,100</b>	<b>6,000</b>

\* Proprietary development costs not included.

**DEPLOYMENT COST ESTIMATES**

(\$ Millions)

Sector	Near Term (5 year)	Mid Term (5 year)	Long Term (10 year)	TOTAL
Public	2,000	8,000	29,000	39,000
Private	5,000	26,000	139,000	170,000
<b>TOTAL</b>	<b>7,000</b>	<b>34,000</b>	<b>168,000</b>	<b>209,000</b>

## Near-Term Actions

Chapter III of this plan, the "Course of Action" details a wide-ranging set of tasks that constitute the IVHS Strategic Plan. Distilled from Chapter III and listed below are key actions to be accomplished in the near-term that will provide a vital impetus to the program and ensure its success.

### From R&D Through Deployment

- Provide consistent, dedicated public funding

A dependable source of funds is essential for effective planning within DOT, as well as for administration and support of activities initiated by federal and state departments of transportation. Furthermore, consistent, predictable public funding can stimulate larger private sector investments. Funding should come from federal, state, and local governments.

- Provide resources for research and development

Although no major scientific breakthroughs are required to accomplish stated goals, substantial R&D and operational testing are needed to develop practical systems and demonstrate their safety, effectiveness, and marketability. Resources will be needed from all IVHS participants.

- Deploy advanced transportation management centers

Transportation management centers will contribute to the integration of traveler information services for public, private, and commercial use. A variety of public and private arrangements can be used to create and operate these centers.

- Test and deploy key services and applications, including:

- Traveler information provided in the home, at the workplace, and at convenient public locations
- In-vehicle safety systems
- In-vehicle route guidance systems.

IVHS will be accepted through the development and availability of products and services useful to the consumer. The private sector should take the initiative in devising, testing, and bringing products to market. Public and private cooperation will be needed to make systems a reality.

- Conduct operational tests for vehicle fleet operations

Priority should be given to products and systems that promote increased productivity and safer and more effective vehicle fleet operations. All IVHS developers and users will benefit from early

testing and implementation of technologies. These operational tests will be achieved through partnerships of state authorities, DOT, and fleet operators.

## Integration

- Create well-defined procedures for operational tests and establish test sites

Guidelines must be established for selecting technologies to be tested, for experimental designs and for evaluation of test results and quantification of benefits. DOT should play a primary role in establishing these guidelines, with major contributions from IVHS AMERICA's technical committees.

Specially selected sites should be identified for operational testing of alternative technologies in multi-modal applications. This can be done using medium- and long-term test projects, instrumenting test beds, and establishing a small number of shared operational test facilities.

- Develop a system architecture

Effective integration of the various components of IVHS requires a system architecture — its design will take time and must draw from multiple disciplines. It must be an open architecture, able to accommodate different system implementations in diverse settings. The architecture should be developed largely by the private sector and academia, with requirements from the public sector, and with primary funding from DOT.

- Promote standards and protocols

Standards and protocols play an important part in product development and in ensuring compatibility among systems. Existing organizations should be relied upon in this standards-setting effort. Existing standards should be adopted or adapted wherever possible. IVHS AMERICA should take a proactive role in defining needs and fostering the overall process.

- Define RF spectrum needs and get appropriate allocation

Many current and proposed tests and several major applications and architectures employ radio frequency (RF) communications. RF spectrum matters often involve extensive analysis as well as political negotiation. IVHS AMERICA should coordinate efforts to define requirements and work with DOT and private industry to seek appropriate RF spectrum allocation from the FCC. Coordination with Canada and Mexico is needed for continent-wide spectrum allocation for IVHS.

## Organizational Program

- Address key institutional issues.

Challenges to the success of IVHS involve important institutional issues. Development of effective public/private partnerships is essential. Establishing IVHS AMERICA was a key step. Institutional arrangements should be developed for combining public and private resources in joint programs.

Cooperation among state and local jurisdictions in the implementation and deployment of IVHS facilities is also of prime importance.

- Seek resolution of key legal issues and procurement procedures

Several legal issues present important challenges to the success of IVHS. Special effort should be initiated now to address two of these, tort liability and privacy issues. DOT should commission studies in these areas and the IVHS AMERICA Legal Issues Committee should continue to address them.

Government agencies should recognize the significant costs and complications for the private sector in doing business with the federal government. Changes to procurement procedures are needed to avoid undue restraint on development.

- Pursue international cooperation

Representatives from all sectors should engage in discussions and exchange of information with international IVHS groups concerning standards, research and development, and testing. The private sector should give consideration to participating in international consortia for the development of IVHS technologies. IVHS AMERICA should continue to foster a global perspective — sharing information and seeking members from around the world.

## Education and Training

- Establish university-based IVHS research and education centers

Centers for IVHS research and education should be established in the academic community. Substantial funding should come from the federal government, with monetary and in-kind contributions from state and local governments and industry.

- Develop the human resources needed to support IVHS

New skills are required for the deployment, operation, and maintenance of IVHS facilities. State departments of transportation and local bureaus of public works will need to provide appropriate training of existing personnel and seek different kinds of professionals.

- Inform the public about progress

It is important that the public and those responsible for and concerned with IVHS be kept fully informed about its development. IVHS AMERICA, through its publications, clearinghouse, and media relations, should report on the progress of the IVHS program.

## Planning

- Update the Strategic Plan and provide advice to DOT

Significant effort in the development of IVHS is taking place and progress is rapid. IVHS AMERICA should institute a mechanism to update the Strategic Plan annually to incorporate the results of IVHS activity as well as the knowledge gained from continuing R&D, operational tests, and deployment.

- Make tactical plan recommendations to DOT

Annual program planning advice should be provided to the DOT to meet federal budgeting requirements for the next two federal fiscal years.

implementable in circumstances where it is needed. IVHS provides the capability to do this. However, IVHS, in and of itself, does not imply the implementation of congestion pricing.

#### ENVIRONMENT

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*"One half of the nation lives in areas exceeding the smog standard."*

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Air quality, particularly in designated urban areas, is an important concern. A U.S. Environmental Protection Agency report<sup>9</sup> states that emissions from transportation sources accounted for 43% of total U.S. emissions of nitrogen oxides, 31% of hydrocarbons, and 66% of carbon monoxide. Urban area contributions are much worse. In Los Angeles, mobile sources account for 59% of the nitrogen oxides, 46% of the hydrocarbons, and 87% of the carbon monoxide. Currently, approximately one-half of the nation lives in areas exceeding the smog standard and one-third lives in areas exceeding the carbon monoxide standard.

Environmental quality is of increasing concern as evidenced by the recent Clean Air Act Amendments (CAAA) and by actions taken by many states in setting high air quality standards. The CAAA list specific transportation related requirements.<sup>6</sup> Transportation systems for the future will continue to take environmental issues into account.

IVHS can be part of the solution to these environmental problems. Smoother traffic flow resulting from improvements in congestion, improved route selection resulting from information to drivers, and diversions to public transportation can reduce environmental impacts.

#### ENERGY

"Transportation is a major consumer of energy, accounting for 27% of U.S. energy consumption and 63% of petroleum consumption in 1989. Both of these relationships are projected to remain relatively stable through 2010."<sup>10</sup> The highway mode dominates the energy picture — in 1988, 73% of the transportation sector's consumption of petroleum was highway-based.<sup>10</sup>

The use of oil for transportation purposes has major national and international implications. Nationally, there are environmental concerns with the development of new sources of oil. There is also concern about the United States' continued dependence on foreign oil, and its attendant foreign policy and national security implications.

It is estimated that two billion gallons of fuel are wasted annually due to congestion. IVHS can help reduce wasted fuel by reducing congestion. As noted above under "Environment," optimal routing and diversion to enhanced public transportation systems can help as well.

#### MOBILITY AND ACCESSIBILITY

In recent years, the concept of universal mobility and accessibility to highway and public transportation has gained acceptance. Accessible, innovative, and comprehensive transportation are critical factors in determining the quality of life for the elderly, the disabled, and the

for high occupancy vehicles. Transit efficiency can be improved through fleet management, making it a better option.

With the eventual development of automated highways, more substantial congestion reduction is feasible. Capacity increases of 100 to 200 percent have been projected in some studies.

The potential attraction of more automobile traffic when IVHS reduces congestion must be recognized and should be studied. IVHS does provide the capability for congestion pricing and demand management, if public policy determines that this is required.

#### INCREASED AND HIGHER- QUALITY MOBILITY

**GOAL:** To enhance mobility and the convenience and comfort of the surface transportation system

#### **OBJECTIVES:**

1. To improve accessibility to the surface transportation system by those at all income and age levels, in all geographic regions, and by the disabled
2. To improve travel time predictability
3. To reduce the level of stress associated with travel
4. To enable travelers to make alternative use of their traveling time for work or leisure activities

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*"IVHS will enhance mobility."*

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The introduction and use of IVHS technologies will enhance people's ability to use the nation's alternative transportation systems, mass transportation systems, rural and specialized services for handicapped people, urban public transportation, taxis, limousines and shuttle buses, car-pool, van-pool and other paratransit services. Ultimately, IVHS will serve the traveler whose trip includes an intercity rail or air segment by providing total integrated information on all travel-making opportunities.

IVHS technologies have the potential to make improvements in trip planning and to provide driving aids en route. For "routine" trips, there may be the ability to determine traffic conditions and current status of transit operations. Information can assist with planning a more reliable trip and can reduce the chances of being late. Advanced technologies like infrared sensing devices can help the vision-impaired driver and the elderly. Having an in-vehicle routing system so "you never get lost" can be a more comfortable, less stressful traveling experience.

Each feature, including those listed above and others, may seem modest, but in the aggregate they can add up to a much more comfortable and convenient trip and substantial mobility improvements.

**IMPROVED ENVIRONMENTAL  
QUALITY AND ENERGY  
EFFICIENCY**

**GOAL:** To reduce the environmental and energy impacts of surface transportation

**OBJECTIVES:**

1. To reduce harmful vehicle emissions
2. To reduce fuel wasted by congestion and travel inefficiencies
3. To reduce surface transportation energy consumption per vehicle-mile and per passenger-mile traveled

Fuel savings are an important target of the IVHS program. There is potential for fuel consumption savings in equipped vehicles on systems with supporting infrastructure.

IVHS will provide balanced vehicle densities and maximum utilization of the infrastructure. When IVHS is implemented, vehicles should travel with minimal starts and stops and at nearly constant speeds. Using current EPA Fuel Economy Label values as a starting point, it is clear that the closer IVHS allows vehicles to perform in the "highway" mode, the higher the benefits.<sup>12</sup>

Fuel savings will also result from improved route selection. In a FHWA study,<sup>32</sup> it was shown that major improvements in distance traveled and time spent traveling could be achieved with navigational aids.

IVHS strategies offer hope for future improvement of air quality, particularly in designated urban areas because impacts will begin upon deployment. Such strategies are complementary to other air quality initiatives, such as alternative fuels.

The key to reduced energy consumption and improved air quality is smoother traffic flow and fewer vehicle miles traveled by automobiles. IVHS has the potential to accomplish this by enhancing capacity through traffic management, navigational aids, support to transit and paratransit and encouragement of their use, and HOV lanes. Also, IVHS offers the capability for controlling additional demand that might reduce environmental and energy efficiency gains.

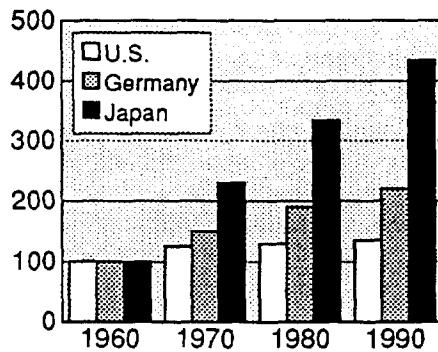
*"IVHS permits vehicles to  
operate at nearly  
constant speeds, saving fuel."*

**IMPROVED ECONOMIC  
PRODUCTIVITY**

**GOAL:** To improve effectiveness and efficiency of the surface transportation system, now and in the future, thereby improving productivity of individuals, organizations and the economy as a whole

## Growth in Productivity

Index




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*"The link between transportation efficiency and productivity has, perhaps, never been so important."*

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*"Investment in IVHS will help national productivity."*

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## OBJECTIVES:

1. To reduce the costs and improve the effectiveness of all users of the surface transportation system — fleets, individual drivers, and mass transportation
2. To make better use of existing facilities and reduce the need for construction of new conventional facilities
3. To reduce the costs associated with and improve the quality of collection of data for transportation planning, operations management, roadway construction and maintenance services, and user fee purposes

The relationship between transportation and the economy is fundamental. Economic activity generates transportation demand and transportation helps the economy grow. Freight transportation and business-related passenger transportation are integral parts of the productive process. Nearly all economic activities use transportation directly or indirectly; cost-reducing improvements in transportation, such as more direct routing, increased speeds, reduced wear and tear on vehicles, or improved safety, increase economic productivity.<sup>6</sup>

The U.S. currently faces a serious challenge in the international marketplace. Our industrial organizations are in a critical struggle for market share, both domestically and abroad. The link between transportation efficiency, broadly defined, and productivity has, perhaps, never been so important. Therefore, a fundamental goal of IVHS is to improve the operation of the U.S. transportation system and the effectiveness of past and future investment in that system.

IVHS can do this through safety improvements, congestion reduction, energy and environmental enhancement, and through the more efficient administration of the surface transportation system. Productivity gains in the trucking and package delivery industry will occur through fleet management, electronic permitting for commercial vehicles, and many other technologies. IVHS has the potential for more effectively operating the infrastructure now in place, reducing the need for construction of new conventional infrastructure.

Investment in transportation through IVHS infrastructure and in-vehicle devices has a direct impact on productivity. "Capital investment, including the development and maintenance of transportation infrastructure offers one of the most effective known catalysts of productivity growth. Transportation investment, and network improvements in particular, can trigger technological innovation in private firms, with important economic gains that extend beyond those previously associated with infrastructure development."<sup>33</sup>

IVHS provides a new range of capabilities in such areas as gathering and providing data, controlling the transportation system, and pricing transportation services. For example, the data available from IVHS on levels of demand, periods of peak use, and identification of locations of recurring congestion will be helpful in overall land use planning, facilities modernization and construction decisions, and operation management.<sup>34</sup>

Improvements in data acquisition and availability will allow the proper and appropriate assignment of user fees and charges to implement federal and local policies in transportation. Equity in financing and pricing of transportation services is achievable.

## Institutional Goals and Objectives

### IVHS INDUSTRY IN THE UNITED STATES

In addition to the goals and objectives tied directly to IVHS operations and deployment, there are several goals and objectives related to important institutional factors connected with IVHS. This section discusses them.

**GOAL:** To develop a viable and profitable U.S.-based IVHS industry

#### OBJECTIVES:

1. To establish a U.S.-based supply industry for in-vehicle IVHS hardware and software
2. To establish a U.S.-based supply industry for IVHS infrastructure hardware and software
3. To establish a U.S.-based IVHS transportation services industry
4. To achieve a substantial market penetration in the U.S. by U.S.-based industry of IVHS hardware, software, and services
5. To establish an international market presence by U.S.-based industry of IVHS hardware, software and services

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*"IVHS is a significant business opportunity for U.S. industry."*

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IVHS represents a significant business opportunity for automakers and for the electronics, computer, navigation, and communications industries. IVHS will add functionality to automobiles, and this increased functionality will increase the value of the automakers' products. That increase in product value translates into expansion in the overall automobile market and would bring with it new business opportunities for companies serving that market. IVHS gives producers an opportunity to sell a wide range of new and enhanced products, building new markets as well as preserving current business.

Software represents an important in-vehicle market as well, including items such as "electronic yellow pages" and in-vehicle route guidance services.

# APPENDIX C

*National ITS Program  
Plan, edited by Euler,  
C.W. et al. (March 1995)*

**THE FULL TEXT OF THE NATIONAL  
PROGRAM PLAN MAY BE FOUND IN COPIES  
OF THE APPENDICES ON FILE WITH  
THE SECRETARY'S OFFICE OF THE  
FEDERAL COMMUNICATIONS COMMISSION**

# NATIONAL ITS PROGRAM PLAN

## EXECUTIVE SUMMARY

FIRST EDITION  
MARCH 1995

Edited by:

Gary W. Euler  
Joint Program Office for ITS  
United States Department of Transportation

H. Douglas Robertson  
Plans and Programs  
ITS America

## Abstract

The purpose of the *National ITS Program Plan* is to guide the development and deployment of Intelligent Transportation Systems (ITS) in the United States. This first edition of the Plan was a joint effort of ITS America and the United States Department of Transportation. The plan was developed through a consensus process involving the entire ITS community. The *National ITS Program Plan* consists two volumes. An Executive Summary and a Synopsis are also available. The Executive Summary provides a very brief overview of the goals, objectives, and recommendations presented in the *National ITS Program Plan*. The Synopsis provides a 50 page encapsulation of the major subject areas within the document, with special emphasis on deployment. Volume I focuses on goals, compatibility, deployment, and program assessment. Volume II contains detailed descriptions and plans for each of the 29 user services.

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